Binghamton University Graduate Combinatorics Algebra and Topology Conference

November 6-7 & November 13-14, 2021

Acknowledgments

There are many people we must thank for helping make this conference happen.

We will start by thanking Dr. Alexander Borisov, the faculty coordinator of the BUGCAT Conference, for his continued help and guidance. This year we tried to include combinatorics in our conference name. It was Dr. Borisov who came up with the name, 'BUGCAT Conference'.

We thank Dr. Kappe and the Kappe family for their generous financial support of our conference in memory of Wolfgang Kappe.

Special thanks go to our secretaries Dianne Anderson and Diana Heggelke and our financial coordinator and building manager Grace Holton for their huge assistance in planning out this conference, made especially difficult due to COVID.

We thank the Binghamton University Department of Mathematical Sciences and our chair Dr. Marcin Mazur.

We thank Jeffrey Nye and everybody else who helped us during the process.

And finally, thank you to all our wonderful participants, moderators, and keynote speakers who make this conference possible!

Signed,
The BUGCAT Conference Organizing Committee

The team of graduate students that organized this conference consisted of Hari Asokan (Facebook page management), Christopher Chia (correspondence), Zachary J Costanzo (advising), Michael Gottstein (announcements), Meenakshy Jyothis (head organizer), Tara Koskulitz (scheduling), Nicholas Lacasse (website management), Ezekiel M Lemann (advertising), Shuchen Mu (announcements), Garrett A Proffitt (budgeting), Mithun Padinhare Veettil (announcements), and Lucas Williams (budgeting and announcements). The Advisory Board consisted of Ulysses Alvarez, Chris Eppolito, and Andrew Lamoureux.

All times are in EST. Graduate student talks are 25 minutes followed by a 5 minute Q&A.

Saturday 11/6

8:50 am Introduction

9:00 am Chaitanya Tappu, *A space of hyperbolic structures for the action of mapping class groups of infinite type surfaces*

9:40 am Joseph Michael Melby, *Asymptotics of the Turaev-Viro Invariants for a Family of 3-manifolds*

10:20 am Ruiter Joshua, *Abstract homomorphisms of special unitary groups*

11:00 am Zihao Liu, *Scaled Homology and Topological Entropy*

11:40 am Danika Van Niel, *Twisted topological Hochschild homology and Mackey functor fields*

12:30 pm **Keynote:** Inna Zakharevich, *From topological spaces to categories and back again*

1:30 pm Lunch

2:30 pm Chloe Lewis, *Computational Tools for Real Topological Hochschild Homology*

3:10 pm Ulysses Alvarez, *Mirrored posets and the Up topology*

3:50 pm Zachary Winkeler, *Khovanov homology for links in thickened multipunctured disks*

4:30 pm Neeti Gauniyal, *Haefliger's surgery theory approach for spherical knots modulo immersions*

5:30 pm Happy Hour: *Online Pictionary*

Sunday 11/7

9:00 am Benjamin Thompson, *The hard yet tantalizing homology of Out(F_n)*

9:40 am Qingyun Zeng, *Lie infinity groupoids and algebroids in singular foliations*

10:20 am Charlotte Aten, *Orientable smooth manifolds are essentially quasigroups*

11:00 am Mark Nieland, *Origamis Associated to Minimally-Intersecting Filling Pairs (follow-up)*

11:40 am Eric Jovinelly, *New Extreme Divisors on $\overline{M}_{0,7}$*

12:30 pm **Keynote:** Dandrielle Lewis, *Reflections on Undergraduate Research*

1:30 pm Lunch

2:30 pm Aaron Heap, *Knot Mosaics*

3:10 pm Wern Yeong, *Algebraic hyperbolicity of very general hypersurfaces in products of projective spaces*

3:50 pm Max Weinreich, *The pentagram map*

4:30 pm Rimma Hamalainen, *Solving Problems in Combinatorial Geometry Using Allowable Sequences*

Saturday 11/13

9:00 am Thodsaporn Kumduang, *Menger hypercompositional algebras represented by medial n-ary hyperoperations*

9:40 am Mehsin Jabel Atteya, *Multiplicative (Generalized)-Derivations with Zero-Power Valued on Rings*

10:20 am Snehashis Mukherjee, *Quantum Spatial Ageing algebra and its representations*

11:00 am Andrew Clickard, *Synthetic Geometry in Hyperbolic Simplices*

11:40 am Cigole Thomas, *Dynamics of the outer automorphism group action on finite field points of character varieties*

12:30 pm **Keynote:** Tara S Holm, *Symplectic Embeddings and Infinite Staircases*

1:30 pm Lunch

2:30 pm Nicki Magill, *Staircase Patterns in Hirzebruch Staircases*

3:10 pm Samuel Tripp, *Integral Grid Homology for Links in Lens Spaces*

3:50 pm Jonathan Doane, *Varieties with constants*

4:30 pm Andrew Tawfeek, *On discrete gradient vector fields of simplicial complexes*

Sunday 11/14

9:00 am Khwancheewa Wattanatripop, *Formulas for counting the complexity of permutational full terms*

9:40 am Harishchandra S. Ramane, *Seidel energy of graphs*

10:20 am Anibal Medina, *Effective constructions in algebraic topology and applications*

11:00 am Val Pinciu, *Coloring Theorems Involving Crossing Numbers, Skewness, Genus, and Thickness of a Graph*

11:40 am Chris Schroeder, *An application of classical number theory to finite group theory*

12:20 pm Elijah Gunther, *Operads, ∞-Categories, and Dendroidal Sets*

12:50 pm Lunch

1:50 pm Dheer Noal, *Spectral Turán Problems*

2:30 pm Lorenzo Ruffoni, *Graphical splittings of Artin kernels*

3:10 pm Eleftherios Chatzitheodoridis, *The Grothendieck group of a ring*

3:50 pm Jiayuan Wang, *Fully commutative elements in complex reflection groups*

4:30 pm Yu-Chan Chang, *Abelian splittings of finitely presented Bestvina-Brady groups*

5:10 pm Sarah Aljohani, *Variations of Primeness and Factorization of Ideals in Leavitt Path Algebras*

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From topological spaces to categories and back again

Inna Zakharevich (Cornell University)

Abstract

One of the most powerful techniques in mathematics is the use of algebra to model geometric phenomena. By turning a geometric problem (often difficult) into an algebraic problem (often easier, sometimes even solvable by computer) we can analyze the problem without understanding what is happening "geometrically." Unfortunately, homotopy types cannot be modeled in this way: algebra is simply too rigid. For example, consider a point and a disk. A point is 0-dimensional, while a disk is 2-dimensional; in order to describe them algebraically different numbers of variables are required. However, from the point of view of homotopy they are the same. Thus if we want to make algebraic models of homotopy types we need algebraic objects which have some kind of "floppiness" built in. Categories, with their possibility of multiple copies of each object, are perfect for this. In this talk we will explore this connection in detail, discussing topological interpretations of category-theoretic models and different methods of modeling familliar spaces using categories

WOLFGANG AND LUISE-CHARLOTTE KAPPE ALUMNI LECTURE

Reflections on Undergraduate Research

Dandrielle Lewis (High Point University)

Abstract

After I got my Ph.D., I joined the University of Wisconsin-Eau Claire, which is an undergraduate institution known for undergraduate research. I had a few ideas for projects, but I did not know exactly how to guide students through a year-long, summer, or semester research project. However, I learned how to navigate this guidance in my first year. Being flexible, meeting students where they are in their mathematical and sometimes other areas of interest journeys, and setting realistic goals is key to making a project accessible. In this talk, I will share how I do undergraduate research, and I will share projects I have worked on with undergraduates.

Symplectic Embeddings and Infinite Staircases

Tara S Holm (Cornell University)

Abstract

McDuff and Schlenk determined when a four-dimensional symplectic ellipsoid can be symplectically embedded into a four-dimensional ball. They found that if the ellipsoid is close to round, the answer is given by an "infinite staircase" determined by the odd index Fibonacci numbers, while if the ellipsoid is sufficiently stretched, all obstructions vanish except for the volume obstruction. Infinite staircases have also been found when embedding ellipsoids into polydisks (Frenkel - Muller, Usher) and into the ellipsoid E(2, 3) (Cristofaro-Gardiner -Kleinman). In this talk, we will see how the sharpness of ECH capacities for embedding of ellipsoids implies the existence of infinite staircases for these and three other target spaces. We will then discuss the relationship with toric varieties, lattice point counting, and the Philadelphia subway system. This is joint work with Dan Cristofaro-Gardiner, Alessia Mandini, and Ana Rita Pires. The talk will be based on pictures and examples.

A space of hyperbolic structures for the action of mapping class groups of infinite type surfaces

Chaitanya Tappu (Cornell University) 9:00 am

In this talk, I will define the moduli space of marked, complete, autoconvex hyperbolic structures on any surface of negative (but not necessarily finite) Euler characteristic, with emphasis on infinite type surfaces. The mapping class group of the surface acts on this marked moduli space, and the action is continuous.

Asymptotics of the Turaev-Viro Invariants for a Family of 3-manifolds

Joseph Melby (Michigan State University) 9:40 am

We will discuss the deep connection between quantum invariants of 3-dimensional manifolds and hyperbolic geometry exemplified by the Turaev-Viro invariant Volume Conjecture. In addition, we will construct an infinite family of 3-dimensional manifolds with interesting combinatorial and topological properties which satisfy the conjecture.

Abstract homomorphisms of special unitary groups

Ruiter Joshua (Michigan State University) 10:20 am

A conjecture of Borel and Tits asserts that abstract homomorphisms between the groups of rational points of algebraic groups admit a factorization in which one of the composite maps is a morphism of algebraic groups. I will discuss the history of this conjecture, especially the work of I. Rapinchuk for the case of Chevalley groups. Extending those methods, I will discuss my recent work on the case of a certain class of special unitary groups.

Scaled Homology and Topological Entropy

Zihao Liu (Brandeis University) 11:00 am

In this talk, I will introduce a scaled homology theory, lc-homology, for metric spaces such that every metric space can be visually regarded as "locally contractible" with this newly-built homology. In addition, after giving a brief introduction of topological entropy, I will discuss how to generalize one of the existing results of entropy conjecture, relaxing the smooth manifold restrictions on the compact metric spaces, by using lc-homology groups. This is joint work with Bingzhe Hou and Kiyoshi Igusa.

Twisted topological Hochschild homology and Mackey functor fields

Danika Van Niel (Michigan State University) 11:40 am

Topological Hochschild homology (THH) is an invariant of ring spectra and is a key component of trace method approach to algebraic K-theory. One of the main computational tools for THH is the Bökstedt spectral sequence. In recent years, a generalization of THH for equivariant ring spectra called twisted THH has been developed along with an equivariant version of the Bökstedt spectral sequence. In this talk we discuss Mackey functor fields, which are an equivariant analog of classical fields, and use them in computations of twisted THH. In this talk I'll introduce Mackey functor fields, twisted THH, and discuss work in progress on computations of twisted THH using the equivariant Bökstedt spectral sequence.

Computational Tools for Real Topological Hochschild Homology

Chloe Lewis (Michigan State University) 2:30 pm

Algebraic K-theory is an invariant of rings that touches interesting questions in many branches of mathematics. Hesselholt and Madsen developed an analogue for rings with anti-involution called Real algebraic K-theory (KR). Given its computational difficulty, an active area of research in algebraic topology explores an approximation of KR called Real topological Hochschild homology (THR). In this talk, we'll construct a tool called the Real Bökstedt spectral sequence which uses the algebraic theory of Real Hochschild homology as an input to assist in THR computations. We'll apply this tool to the spectrum $MU_{\mathbb{R}}$.

Mirrored posets and the Up topology

Ulysses Alvarez (Binghamton University) 3:10 pm

Topological posets are Hausdorff spaces with a partial ordering where the relation is closed in the product space. These objects allow for the construction of a space which can be viewed as a generalization of the order complex of a discrete poset. We will discuss how this structure can be used to understand the topology of a corank 1 matroid over the tropical phase hyperfield.

Khovanov homology for links in thickened multipunctured disks

Zachary Winkeler (Dartmouth College) 3:50 pm

Khovanov homology is a knot invariant that categorifies the Jones polynomial. For knots in a thickened annulus, we can define a filtration on the Khovanov chain complex that gives us an invariant called annular Khovanov homology. In this talk, we will discuss a generalized notion of filtration that allows us to construct an analogous invariant for knots in thickened disks with any number of punctures.trees, each representing a particular sort of composition, analogous to the simplices of a quasicategory.

Haefliger's surgery theory approach for spherical knots modulo immersions

Neeti Gauniyal (Kansas State University) 4:30 pm

In 1960s, Haefliger proved that the group C_n^q of isotopy classes of spherical embeddings $S^n \hookrightarrow S^{n+q}$ is isomorphic to a homotopy group of a triad $(SG; SO, SG_q)$ for $q \geq 3$. In this talk, we will apply Haefliger's work to see that the group of spherical (long) embeddings modulo immersions is isomorphic to the homotopy group $\pi_n(SG, SG_q)$ for $q \geq 3$.

The hard yet tantalizing homology of Out(F_n)

Benjamin Thompson (Cornell University) 9:00 am

Very little is known about the homology of automorphism groups of free groups F_n. Calculations of Euler characteristic indicate there is a lot of rational homology when $n > 8$, yet no non-trivial classes in this range are known. Some non-trivial classes are known for $n \leq 8$ though, and we attempt to summarize them in this talk. We briefly cover Morita and Eisenstein classes, Bartholdi's result on Out(F_7), and some results by Conant, Hatcher, Kassabov and Vogtmann which may help push our understanding of these groups beyond $n = 8$.

Lie infinity groupoids and algebroids in singular foliations

Qingyun Zeng (University of Pennsylvania) 9:40 am

We use Lie infinity groupoids and L infinity algebroids in studying higher structures arising in differential geometry. We study the homotopy coherent representations of Lie infinity groupoids and L infinity algebroids, and apply them to (singular) foliations. Finally, we prove an A infinity version of de Rham theorem, and a higher Riemann-Hilbert correspondence for foliated infinity local systems.

Orientable smooth manifolds are essentially quasigroups

Charlotte Aten (University of Rochester) 10:20 am

In my recent with work Semin Yoo we produced a generalization of a construction of Herman and Pakianathan which assigns to each finite noncommutative group a closed surface in a functorial manner. We give a pair of functors whose domain is a subcategory of a variety of n-ary quasigroups. The first of these functors assigns to each such quasigroup a smooth, flat Riemannian manifold while the second assigns to each quasigroup a topological manifold which is a subspace of the metric completion of the aforementioned Riemannian manifold. I will give examples of these constructions, draw some pictures, and argue that all homeomorphism classes of smooth orientable manifolds arise from this construction.

Origamis Associated to Minimally-Intersecting Filling Pairs (follow-up)

Mark Nieland (Rochester Institute of Technology) 11:00 am

Lochack (2005) defined an *origami* as a surface built from finitely-many squares according to three simple rules: 1) Every left edge is glued to a right edge; 2) Every top edge is glued to a bottom edge; 3) The surface is connected. Let α and β be essential simple closed curves (scc's) on the closed, orientable surface S_g of genus g; the pair $\{\alpha, \beta\}$ is a *filling pair* if $S_g \setminus (\alpha \cup \beta)$ is a union of topological disks. It can be shown that, on S_g, the geometric intersection number of a filling pair is at least $2g - 1$. We present a construction that produces a collection of distinct (i.e., mutually-nonhomeomorphic) filling pairs which intersect minimally and naturally give rise to origamis. The number of pairs in this collection grows factorially in g. Joint work with T. Aougab and W. Menasco.

New Extreme Divisors on $\overline{M}_{0,7}$

Eric Jovinelly (University of Notre Dame) 11:40 am

We show $\overline{M}_{0,7}$ has at least 102,123 extreme divisors contained in 37 S_7-orbits over characteristic 0, 101,052 of which (31 S_7-orbits) were previously unknown. Over characteristic 2, we identify two more S_7-orbits of extreme divisors, and prove $\overline{\text{Eff}}_k(\overline{M}_{0,n})$ is strictly larger over characteristic 2 than it is over characteristic 0, for all $n-4 \geq k \geq 3$. Moreover, we prove nonpolyhedrality of $\text{Eff}_k(\overline{M}_{0,n})$ for $n-4 \geq k \geq 6$ by constructing extreme cycles of higher codimension on $\overline{M}_{0,n}$ from those on $\overline{M}_{0,n-k}$. Our methods for finding new extreme divisors on $\overline{M}_{0,7}$ apply more generally to other varieties. In particular, we prove polyhedrality of $\text{Eff}(\overline{M}_{0,\mathcal{A}})$ for $\mathcal{A} = (\frac{1}{3}, \frac{1}{3}, \frac{1}{3}, \frac{1}{3}, \frac{1}{3}, \frac{1}{3}, 1)$ and illustrate simplifications to traditional computational methods by providing a computer-free proof of a result by Hassett and Tschinkel.

Knot Mosaics

Aaron Heap (SUNY Geneseo) 2:30 pm

Knot mosaics, which are representations of knot diagrams on a square array created using tiles chosen from a specific list of eleven mosaic tiles, were first introduced by Lomonaco and Kauffman in 2008. They introduced the mosaic number of a knot, which is the smallest size mosaic on which the knot can be represented. We introduce the concept of a space-efficient knot mosaic, which uses the least number of non-blank tiles necessary to depict the knot. This least number is called the tile number of the knot. In this talk, we will discuss these introductory concepts and provide an update on the table of knot mosaics. Knot mosaic theory is a great source of open problems and research projects, and if time permits, we will discuss a few of these unanswered questions.

Algebraic hyperbolicity of very general hypersurfaces in products of projective spaces

Wern Yeong (University of Notre Dame) 3:10 pm

A complex algebraic variety is said to be hyperbolic if it contains no entire curves, which are non-constant holomorphic images of the complex line. Demailly introduced algebraic hyperbolicity as an algebraic version of this property, and it has since been well-studied as a means for understanding Kobayashi's conjecture, which says that a generic hypersurface in dimensional projective space is hyperbolic whenever its degree is large enough. In this talk, we study the algebraic hyperbolicity of very general hypersurfaces of high bi-degrees in $\mathbb{P}^m \times \mathbb{P}^n$ and completely classify them by their bi-degrees, except for a few cases in $\mathbb{P}^3 \times \mathbb{P}^1$. We present three techniques to do that, which build on past work by Ein, Voisin, Pacienza, Coskun and Riedl, and others. As another application of these techniques, we simplify a proof of Voisin (1988) of the algebraic hyperbolicity of generic high-degree projective hypersurfaces.

The pentagram map

Max Weinreich (Brown University) 3:50 pm

We will explore the dynamics of the pentagram map, a simple geometric operation on polygons. We will explain what it means to be a discrete integrable system, and interpret the meaning of this definition over finite fields.

Solving Problems in Combinatorial Geometry Using Allowable Sequences

Rimma Hamalainen (California State University) 4:30 pm

Allowable Sequences are a powerful tool in combinatorial geometry, notably used to solve various problems by Goodman and Pollack (1980, 1981) and also used by Ungar (1982) to show that $2n$ points in the plane determine at least $2n$ distinct directions. We derive various classifications of such configurations of points and lines using allowable sequences. In particular, we are curious about configurations where the only non-ordinary lines in the configuration all pass through the center of symmetry.

Menger hypercompositional algebras represented by medial n-ary hyperoperations

Thodsaporn Kumduang (Chiang Mai University) 9:00 am

A Menger algebra is a pair of a nonempty set and an operation of arity $(n+1)$ which satisfies the superassociative property. Based on the study of medial operations and medial algebras, in this paper, the necessary and sufficient conditions under which a Menger algebra can be isomorphically represented by medial n-ary operations are proposed. Since a Menger hypercompositional algebra can be regarded as a generalization of a Menger algebra, for this reason, the situation for medial hyperoperations is further examined and a representation theorem of Menger hypercompositional algebras by such concepts is proved.

Multiplicative (Generalized)-Derivations with Zero-Power Valued on Rings

Mehsin Jabel Atteya (Al-Mustansiriyah University) 9:40 am

During the last two decades, the commutativity of associative rings with derivations have become one of the focus points of several authors and significant work has been done in this direction. Ring theory is a showpiece of mathematical unification, bringing together several branches of the subject and creating a powerful machine for the study of problems of considerable historical and mathematical importance. Rings with derivations are not the kind of subject that undergoes tremendous revolutions. The study of derivation was initiated during the 1950s and 1960s. Derivations of rings got a tremendous development in 1957, when Posner [1] established two very striking results in the case of prime rings. Let R be a ring. A map $d : R \longrightarrow R$ is called a derivation if $d(x+y) = d(x) + d(y)$ and $d(xy) = d(x)y + xd(y)$ for all $x, y \in R$. An additive mapping $D : R \longrightarrow R$ is called a generalized derivation if there exists a derivation d of R such that $D(xy) = D(x)y + xd(y)$ holds for all $x, y \in R$. Accordingly, a mapping $D : R \longrightarrow R$ (not necessarily additive) is called multiplicative (generalized)-derivation associated with a map $d : R \longrightarrow R$ (not necessarily additive nor a derivation) if $D(xy) = D(x)y + xd(y)$ for all $x, y \in R$. The idea of such mappings was introduced by Daif [2] inspired by the work of Martindale [3]. For a positive integer $n(x) > 1$ such that $d^{n(x)}(x) = 0$ for all $x \in R$, the mapping $d : R \longrightarrow R$ is called a zero-power valued on R. The main purpose of this paper is to study multiplicative (generalized)-derivations with zero-power valued on prime and semiprime rings. Precisely, we prove the commutativity of a ring R which satisfied certain conditions These results are in the sprite of the well-known theorem of the commutativity of prime and semiprime rings with derivations satisfying certain polynomial constraints.

Quantum Spatial Ageing algebra and its representations

Snehashis Mukherjee (RKMVERI) 10:20 am

In 2016, V.V.Bavula and T. Lau introduced the quantum version of 1-Spatial Ageing algebra namely the Quantum Spatial ageing algebra. They studied the prime ideals, primitive ideals and weight modules over this algebra for the generic case. In this lecture we will show that this algebra becomes a polynomial identity algebra for the non generic case. We will also compute its PI-degree and finally classify all the simple modules over the algebra to show the relation between PI-degree and dimensions of simple modules over an algebra.

Synthetic Geometry in Hyperbolic Simplices

Andrew Clickard (Bloomsburg University) 11:00 am

Let τ be an n-simplex and let g be a metric on τ with constant curvature κ. The lengths that g assigns to the edges of τ, along with the value of κ, uniquely determine all of the geometry of (τ, g). In this paper we focus on hyperbolic simplices ($\kappa = -1$) and develop geometric formulas which rely only on the edge lengths of τ. Our main results are distance and projection formulas in hyperbolic simplices, as well as a projection formula in Euclidean simplices. We also provide analogous formulas in simplices with arbitrary constant curvature κ.

Dynamics of the outer automorphism group action on finite field points of character varieties

Cigole Thomas (George Mason University) 11:40 am

If G is a reductive algebraic group over $\mathbb{Z}$, the G-character variety of a finitely presented group Γ parametrizes the set of closed conjugation orbits in $\mathrm{Hom}(\Gamma, G)$. The group of outer automorphisms, $Out(\Gamma)$, naturally acts on the character variety. The dynamics of this action on the finite field points of character variety is particularly interesting. We explore the transitivity properties of this action. Specifically, we show that when Γ is of free type, that is, $Aut(\Gamma)$ has certain desirable properties, the action is transitive on the set of epimorphisms from Γ to G. We also look at the $\mathrm{SL}_2(\mathbb{F}_q)$-character variety of $\mathbb{Z}^r$, determined by the set of all r-tuples of matrices that commute pairwise, that is being acted upon by the group $\mathrm{GL}_r(\mathbb{Z})$.

Staircase Patterns in Hirzebruch Staircases

Nicki Magill (Cornell University) 2:30 pm

McDuff and Schlenk determined the ellipsoidal embedding capacity function for a four-dimensional ball. They found that infinitely many obstructions given by Fibonacci numbers affect the capacity function. This talk will focus on determining whether ellipsoidal embeddings into Hirzebruch surfaces are given by infinitely or finitely many obstructions. The main proof strategy we will discuss is using almost toric fibrations to construct embeddings. Some of this is joint work with Tara Holm, Dusa McDuff, and Morgan Weiler.

Integral Grid Homology for Links in Lens Spaces

Samuel Tripp (Dartmouth College) 3:10 pm

Knot Floer homology is a powerful invariant of knots and links introduced independently by Ozsvath and Szabo, and by Rasmussen, as a refinement of Heegaard Floer homology. It was given a combinatorial description for links in by Manolescu, Ozsvath, Szabo, and Thurston, and for links in lens spaces by Baker, Grigsby, and Hedden. The combinatorial description gives a chain complex generated by certain intersection points on a grid diagram, whose differential counts embedded parallelograms in that grid diagram. We prove combinatorially that the homology of this chain complex is a link invariant for links in lens spaces. Using a sign assignment on parallelograms on the grid, Celoria generalized this differential to count embedded parallelograms with sign. We show that our combinatorial proof of invariance can be extended over the integers, allowing us to define a version of grid homology over the integers for links in lens spaces.

Varieties with constants

Jonathan Doane (Binghamton University) 3:50 pm

Rings and groups are among the many classes of (universal) algebras, called varieties, which contain constant(s) as part of their structure. In fact, the ring with unity R=¡0,1;+,x,0,1¿ whose only elements are constants, generates a variety interesting in its own right, namely Boolean rings. Notably, R is 0-generated as it is required to contain both 0 and 1. This talk aims to provide a small, general theory for those varieties which are generated by a single 0-generated algebra.

Formulas for counting the complexity of permutational full terms

Khwancheewa Wattanatripop (Khon Kaen University) 9:00 am

The algebraic approach to terms, especially permutational full terms, terms in which each variable constructed from permutations on a finite chain, led to various developments in universal algebra and theoretical computer science. Terms can be represented by tree diagrams and can be counted by many inductive formulas. In this talk, five types of formal inductive definitions for measuring the complexity are presented, including the longest and shortest distance from a first operation symbol that appears in a permutational full term to variables, the number of variable and operation symbols occuring in a permutational full term. An interaction between these various measurements and semantic trees is described. Particularly, valuation of permutational full terms, which is a general form of such complexity, is presented. Formulas for counting those kinds of the complexity of permutational full terms under mappings called superposition operations and hypersubstitutions are established.

Seidel energy of graphs

Harishchandra S. Ramane (Karnatak University) 9:40 am

A Seidel matrix of a graph G of order n is a square matrix of order n, in which the (i, j)-th entry is 1 if the vertices vi and vj are not adjacent, -1 if the vertices vi and vj are adjacent and diagonal elements are zeros. The Seidel energy of a graph is defined as the sum of the absolute values of the eigenvalues of Seidel matrix. In this paper we present some results on the Seidel energy. Further we construct Seidel equienergetic graphs.

Effective constructions in algebraic topology and applications

Anibal Medina (Max Planck Institute for Mathematics) 10:20 am

There is some tension between functoriality and constructibility in algebraic topology reaching back to its origins. For example, the cohomology of a space X could be described in terms of homotopy classes of maps from X to certain spaces, or via a cochain complex generated by a combinatorial representation of X. In this survey talk we will discuss effective constructions of finer structure enhancing the cohomology of X in combinatorial terms. This so called E-infinity structure and associated cochain level operations on X, have become important for new applications of cohomology in the study of, for example, topological QFTs and persistent homology.

Coloring Theorems Involving Crossing Numbers, Skewness, Genus, and Thickness of a Graph

Val Pinciu (Southern Connecticut State University) 11:00 am

A conjecture by Albertson states that if $\chi(G) \geq n$ then $cr(G) \geq cr(K_n)$, where $\chi(G)$ is the chromatic number of G and $cr(G)$ is the crossing number of G. This conjecture is true for positive integers $n \leq 16$, but it is still open for $n \geq 17$.

In this paper we consider the statements corresponding to this conjecture where the crossing number of G is replaced with the skewness $\mu(G)$ (the minimum number of edges whose removal makes G planar), the genus $\gamma(G)$ (the minimum genus of the orientable surface on which G is embeddable), and the thickness $\theta(G)$ (the minimum number of planar subgraphs of G whose union is G.) We show that the corresponding statements are true for all positive integers n when $cr(G)$ is replaced with $\mu(G)$ or $\gamma(G)$. We also show that the corresponding statement is true for infinitely many values of n, but not for all n, when $cr(G)$ is replaced with $\theta(G)$.

All the statements in this paper generalize the Four Color Theorem from planar to non-planar graphs.

An application of classical number theory to finite group theory

Chris Schroeder (Binghamton University) 11:40 am

In this talk, we discuss an alternative (if longer) proof of an important solvability result in the representation theory of finite groups. Namely, if all the irreducible ordinary characters lying over an invariant character of a normal subgroup have relative odd degree, then the quotient by the normal subgroup is solvable. Our method relies on proving a number theoretical fact about divisors of Fermat numbers.

Operads, ∞-Categories, and Dendroidal Sets

Elijah Gunther (University of Pennsylvania) 12:20 pm

Lurie and Joyal developed the use of quasicategories, a type of simplicial set, as a geometric model for ∞-categories. In this model, a 1-simplex represents a morphism and an n-simplex represents the composition of n composable morphisms given by its 1-faces. Categories can be generalized to operads, which allow for k-ary multimorphisms or operations from k objects to one. As an example, multilinear functions from the product of k vector spaces to a single vector space. Moerdijk and Weiss then introduced dendroidal sets to model ∞-operads. In this talk, I will explain how dendroidal sets give a geometric model of ∞-operads, generalizing both operads and quasicategories. Just as in a category morphisms compose linearly, in an operad they compose in the shape of a tree, with multiple branches coming together into a single trunk. Dendroidal sets are then formed as a union of dendrices which look like trees, each representing a particular sort of composition, analogous to the simplices of a quasicategory.

Spectral Turán Problems

Dheer Noal (University of Delaware) 1:50 pm

The odd wheel W_{2k+1} is the graph formed by joining a vertex to a cycle of length $2k$. The (k, r)-fan is the graph consisting of k copies of the complete graph K_r which intersect in a single vertex, and

is denoted by $F_{k,r}$. In this talk, we will investigate the largest value of the spectral radius of the adjacency matrix among all n-vertex graphs that do not contain some subgraph. We will compare the structures of the Turán-extremal and spectral extremal graphs for some examples. We show that for small odd wheels and all fans, the spectral extremal graphs are among the Turán-extremal graphs on n vertices, but for larger wheels the family of spectral extremal graphs and the family of Turán-extremal graphs are disjoint. We will give an overview of similar results and describe a method that may help us find new ones. This is joint work with Sebastian Cioabă (University of Delaware), Liying Kang (Shanghai University), Yongtao Li (Hunan University), Zhenyu Ni (Shanghai University), Michael Tait (Villanova University) and Jing Wang (Shanghai University).

Graphical splittings of Artin kernels

Lorenzo Ruffoni (Tufts University) 2:30 pm

A main feature of the theory of right-angled Artin groups (RAAGs) consists in the fact that the algebraic properties of the group can be described in terms of the combinatorial properties of the underlying graph. We investigate how this can be exploited in the study of Artin kernels, i.e. subgroups of RAAGs obtained as kernels of integral characters. In the case of chordal graphs we obtain a sharp dichotomy for Artin kernels. For block graphs we obtain an explicit rank formula, and discuss some applications to the study of fibrations and BNS invariants of RAAGs. This is joint work with M. Barquinero and K. Ye.

The Grothendieck group of a ring

Eleftherios Chatzitheodoridis (University of Virginia) 3:10 pm

We discuss Chapters 1-3 of the speaker's undergraduate thesis "On the Karoubi envelope and the Serre-Swan Theorem" at the University of Aberdeen, under the kind supervision of Dr. Irakli Patchkoria. Firstly, we construct the group completion of an abelian monoid, extend it to a functor from abelian monoids to abelian groups, and present some noteworthy and useful computations. This enables us to construct the Grothendieck group (often denoted by K_0) of a ring and discuss some important computations and remarks. (Note: Very basic Module Theory, at the level of the introductory study of free/projective/finitely-generated modules over a ring, is essentially presupposed.)

Fully commutative elements in complex reflection groups

Jiayuan Wang (George Washington University) 3:50 pm

Fully commutative elements in types B and D are completely characterized and counted by Stembridge. Recently, Feinberg-Kim-Lee-Oh have extended the study of fully commutative elements from Coxeter groups to the complex setting, giving an enumeration of such elements in $G(m, 1, n)$. In this note, we prove a connection between fully commutative elements in B_n and in $G(m, 1, n)$, which allows us to characterize fully commutative elements in$G(m, 1, n)$ by pattern avoidance. Furthermore, we present a counting formula for such elements in $G(m, 1, n)$.

Abelian splittings of finitely presented Bestvina–Brady groups

Yu-Chan Chang (Oxford College of Emory University) 4:30 pm

A right-angled Artin group splits over an abelian subgroup if and only if its defining graph contains a separating clique. In this talk, I will discuss a similar characterization for finitely presented Bestvina–Brady groups. If time permits, I will talk about joint work with Lorenzo Ruffoni on BNS-invariants for Bestvina–Brady groups.

Variations of Primeness and Factorization of Ideals in Leavitt Path Algebras

Sarah Aljohani (Saint Louis University) 5:10 pm

In this paper we describe three different variations of prime ideals: strongly irreducible ideals, strongly prime ideals and insulated prime ideals in the context of Leavitt path algebras. We give necessary and sufficient conditions under which a proper ideal of a Leavitt path algebra L is a product as well as an intersection of finitely many of these different types of prime ideals. Such factorizations, when they are irredundant, are shown to be unique except for the order of the factors. We also characterize the Leavitt path algebras L in which every ideal admits such factorizations and also in which every ideal is one of these special type of ideals.

Note: This concludes the conference; thank you for attending!